THE EFFECTIVENESS OF MARKET DEVELOPMENT PROGRAMS FOR U.S. DAIRY PRODUCTS

A Thesis

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ABSTRACT

This study examines the effectiveness of U.S. dairy export promotion programs on increasing foreign demand and enhancing producers' revenues. The analysis is based on two econometric models. An import demand equation based on panel data is derived to measure the responsiveness of U.S. dairy import demand in various countries to dairy export promotion. The Armington model is adopted to analyze both the short-run and long-run promotion effects on the market share. Then, the import demand model is used to simulate several in-sample scenarios involving alternative funding levels for export promotion to calculate average and marginal benefit-cost ratios for the programs. The results of this study indicate that the market development programs have increased the demand for U.S. dairy products in the foreign markets over the years, and they have generated an impressive positive return to producers for each dollar spent on promotion. It appears that market development programs were underfunded from a producer-welfare perspective unless the marginal rate of return on alternative uses of promotion was high.

BIOGRAPHICAL SKETCH

Liang Song was born and raised in Shanghai, China. She obtained her B.S. in management and B.S. in Economics from Krannert School of Management, Purdue University in 2012, graduating with high distinction and with honors in Economics. Afterwards, she joined the Department of Applied Economics and Management (Dyson School) at Cornell University, advised by Prof. Harry Kaiser. Her interests lie in marketing research, policy analysis, pricing strategy and consumer behavior. After finishing the Masters program, she will move back to Shanghai, and devote herself in helping start-up companies to refine their marketing strategy.

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INTRODUCTION

Dairy Market Overview

The dairy industry is one of the world's largest and most dynamic sectors in the agricultural and food economy. The major trading countries and regions (New Zealand, European Union, United States, Australia, and Japan) have sharply different levels of protectionist policies and attitudes towards trade liberalization (Jesse, 2003). As stated by (Langley, Somwaru, and Normile, 2006), countries having high levels of protection, like Japan and South Korea, usually produce dairy products at a higher cost, and will lose production value when trade barriers are reduced. Regions/countries having moderate levels of protection, like the European Union and Canada, that use the world market to export their excess dairy production, resist elimination of export subsidies. Dairy industries in countries having the lowest costs, like New Zealand and Australia, generate most of their income from trade and heavily rely on the dairy industry to support the entire economy. These countries insist on lowering trade barriers and export subsidies, so as to strengthen their market power and benefit from a higher world price.

The dairy industry in the United States has undergone a significant change from being a net importer to a net exporter of dairy products over the last decade. Several economic factors, such as the strong global demand for new dairy products, economic growth and increasing dietary needs from emerging markets, changes in technology, and favorable currency rates for the U.S. dollars, have presented more opportunities for U.S. dairy producers to increase their share of the world market. In 2013, the value of U.S. dairy exports topped $5.12 billion, an increase of 8% over the previous year, which represents 13.2% of total dairy production. At the

same time, U.S. dairy imports increased 9% to $3.19 billion (U.S. Dairy Export Council, 2013). The top markets for U.S. dairy exports in the first half of 2013 were Mexico ($670 m), Southeast Asia ($606 m), Middle East ($358 m), Canada ($334 m), and China ($272 m); the fastest growing markets were Middle East (38%), China (26%) and Canada (22%) (U.S. Dairy Export Council, 2013).

In addition to favorable economic conditions, growth in U.S. dairy exports has also been helped by export promotion programs, which are designed to enhance U.S. dairy exports. There are two main categories of export and food aid programs to encourage this expansion of exports: (1) direct export subsidies, and (2) market development programs. In 2012, the U.S. Dairy Export Council (USDEC) received $4.16 million from the Market Access Program (MAP) (USDA, 2011) and another $0.55 million from the Foreign Market Development Program (FMDP) (USDA, 2011) to promote U.S. dairy exports.

While there have been many studies that have focused on the domestic marketing activities of the U.S. dairy industry, there is only one paper, to our knowledge, that has analyzed the impact of dairy export promotion expenditures on foreign demand in selected countries (Olukoya, 2008). The author of this study did not find any significant impact of promotion on export demand.

Objective

Given the limited number of economic evaluation studies and the importance of exports to the U.S. dairy industry, the purpose of this study is to measure the effectiveness of U.S. dairy export promotion programs on increasing foreign demand and enhancing producers' revenues. Similar to previous studies for other, non-dairy commodities, this study examines the impact of

U.S. export promotion (private and government funds) in increasing foreign demand and market shares in selected countries and regions. An import demand equation based on panel data is used to accomplish the goal of this study. The effects of various promotion scenarios on the dairy market are simulated, and benefit-cost ratios (BCSs) for these programs are estimated. In addition, this study measures the impacts of export promotion programs on three most promoted dairy commodities.

U.S. Dairy Export Promotion Program

There are several export promotion programs for U.S. dairy products in foreign markets, including the Dairy Export Incentive Program (DEIP), MAP, and FMDP. Through these agricultural export programs, the United States Department of Agriculture (USDA) assists U.S. agricultural and food organizations in expanding the demand for dairy products in the international markets. The following discusses each in detail.

1. *Direct Subsidy*

The DEIP[1] is administrated by the Foreign Agricultural Service (FAS), which helps exporters of U.S. dairy products compete internationally at prevailing world prices for targeted dairy products and destinations through direct export subsidies. Under the program, the USDA pays cash to exporters as bonuses, which enables them to sell certain U.S. dairy products at prices lower than the exporter's costs of acquiring them. The major objective of the program is to make U.S. dairy products more competitive in the world market. However, the budget expenditures under DEIP have been restricted due to an agreement reached at the Uruguay

[1] Additional information on DEIP is available at http://www.fas.usda.gov/excredits/deip/deip-new.asp

Round (Hanrahan, 2006). The 2008 farm bill reauthorized $100 million under the DEIP for FY2009 and $2 million for FY2010. No DEIP funding is anticipated after that (Hanrahan, 2013).

2. Market Development Program

MAP and FMDP are also administered by the FAS and share some major similarities. For instance, both programs are funded through the borrowing authority of Commodity Credit Corporation (CCC); both of them form partnerships between the U.S. government and numerous non-profit agricultural trade associations and regional groups; they each use similar mechanisms in selecting proper applicants. In addition, as MDPs, they are considered to be non-trade distorting by WTO, and therefore they are exempt from spending constraints from trade agreements (Hanrahan, 2006). The marketing activities for international market development program fall into three categories: trade servicing[2], technical assistance[3] and consumer promotion[4] (Solomon and Kinnucan, 1993). These activities help U.S. agricultural commodities differentiate themselves from competitors and help to outreach foreign markets more smoothly.

The MAP[5] primarily promotes high-value consumer-oriented goods with either brand promotion or generic promotion. Through the program, industry associations or firms without industry representatives can submit proposals to apply for government assistance in marketing activities. The industry organizations can either undertake promotion activities themselves or fund members' marketing activities that include trade servicing, technical assistance, and consumer promotions. After the project is completed, FAS partially reimburses the approved

[2] Trade Serving is designed to facilitate interactions through dissemination of information about availability, utility, and reliability of US suppliers, which helps importers to procure US products.
[3] Technical Assistance is designed to increase the utilization of US agricultural commodities in the production process of foreign countries, which includes teaching customers about the specific uses of US commodities.
[4] Consumer Promotion include store demonstrations, media advertising, recipes and nutrition information, and event sponsorship. It aims to increase overseas demand directly at the retail level.
[5] Additional information on MAP is available at http://www.fas.usda.gov/mos/programs/map.asp

organizations or entities with a certain proportion of the promotion cost. For generic advertising, industry organizations and others must provide at least 10% of the total funding; for brand promotion, companies should provide a minimum of 50% to meet the requirements.

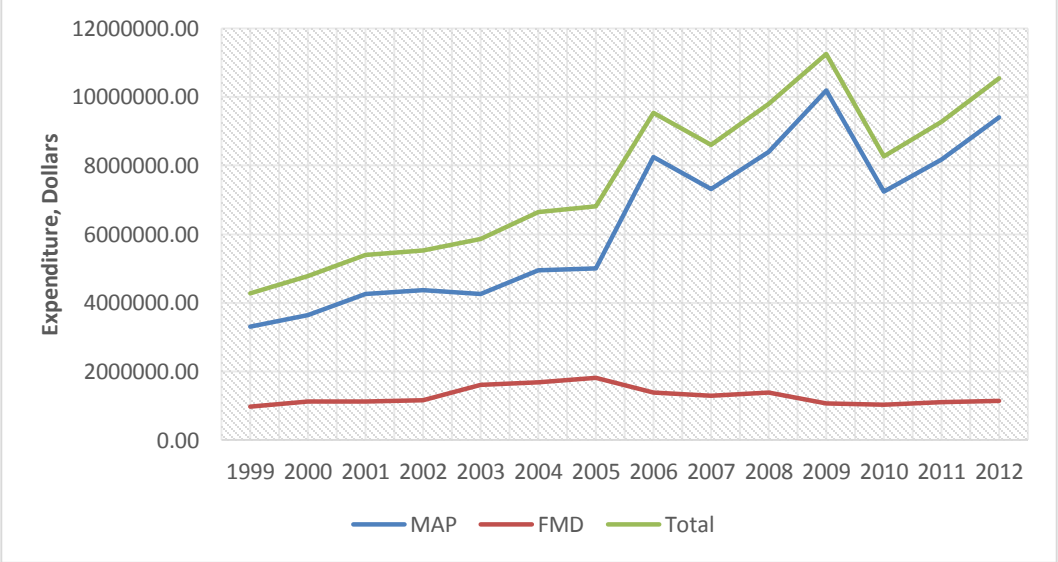

Figure 1: U.S. Market Development Programs Yearly Expenditure by Programs

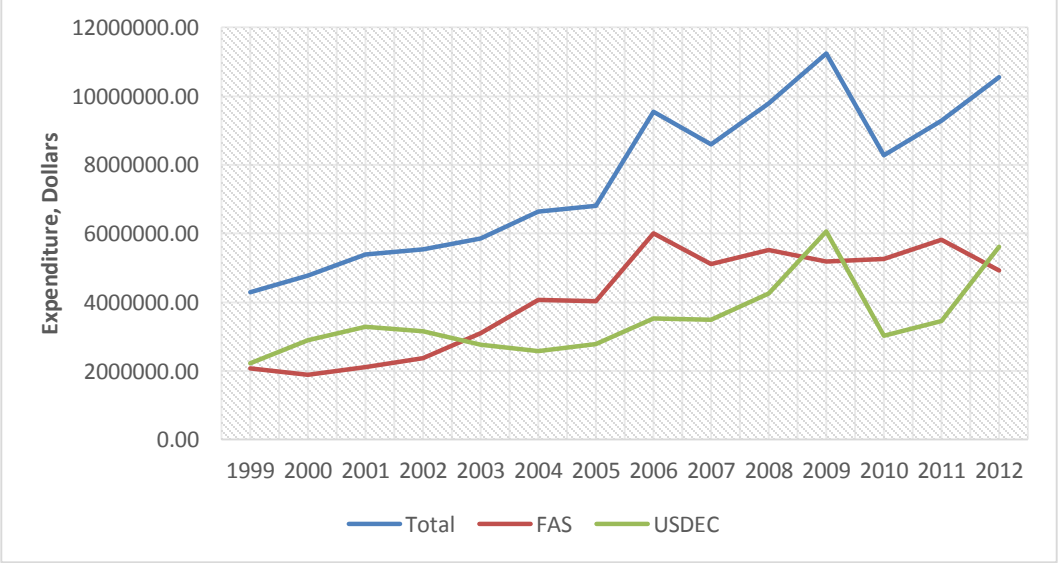

Figure 2: U.S. Market Development Programs Yearly Expenditure by Agency

Typically, about 60% of MAP funds support generic promotion. However, starting from FY 1998, USDA began to allocate all MAP funds for promotion of branded products to cooperatives and small U.S. companies (Hanrahan, 2006). During the past decade, total MAP expenditures for dairy products increased dramatically from $3.31 million in 1999 to $9.40 million in 2012 (Figure 1). This supportive program mainly covered 11 countries and regions: Mexico, China, Japan, South Korea, South America, Southeast Asia, Europe Union, Middle East, Taiwan, Vietnam, and Caribbean (Figure 3), from eight different aspects (Table 1).

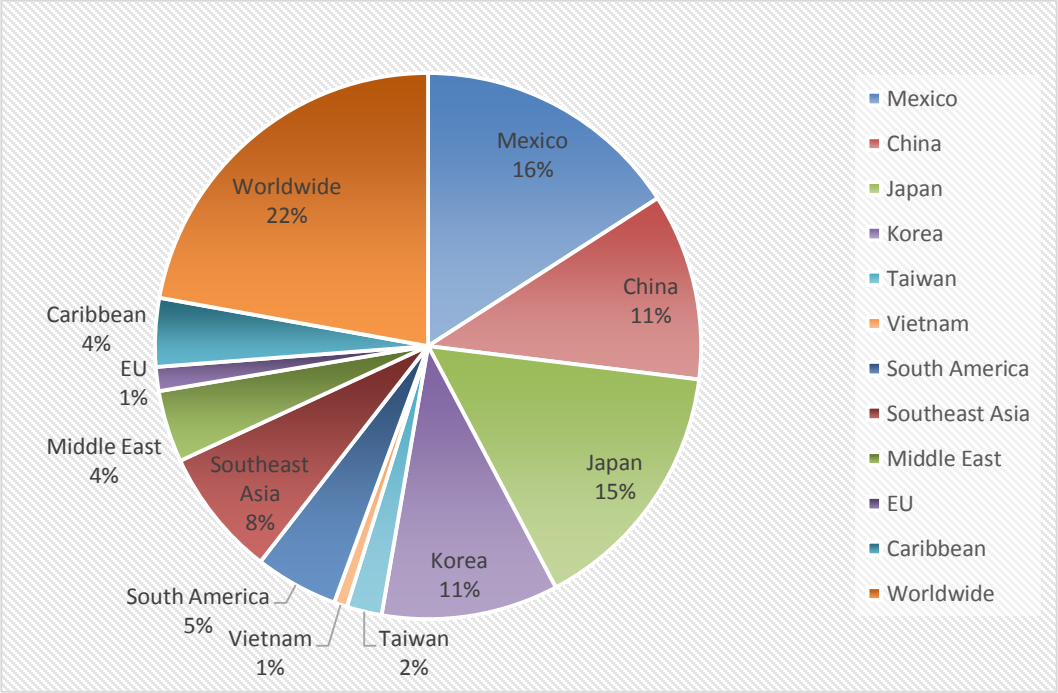

Figure 3: Average Annual MAP Expenditure by Country

The FMDP[6] mainly applies to promotion of bulk commodities and emphasizes long-term market development rather than short-term. Similar to the MAP, the program is a cost-sharing partnership between USDA and industry organizations (also called cooperators), and the

[6] Additional information on FDMP is available at http://www.fas.usda.gov/mos/programs/fmdprogram.asp

government reimburses cooperators for the qualified portion of promotion activities after they are completed. Participants must contribute no less than 50% of CCC expenditures for the FMDP program. In 2012, a total of $0.97 million from both FAS and USDEC was spent on dairy promotion through FMDP. Total FMDP expenditures have increased an average of 2.4% annually, compared to the amount spent in 1999 (Figure 1). The program expenditures have been concentrated in eight countries and regions (Figure 4) by funding four types of activities (Table 2). Overall, proponents of MDPs argue that they benefit the U.S. in a variety of ways including increasing exports and job creation. In this study, we focused on the total expenditures on the selected countries and regions, but exclude the worldwide total expenditures, which means we only included 78% of MAP and 54% of FMDP expenditures. In this case, the estimation of promotion impacts on demand could be biased upwards.

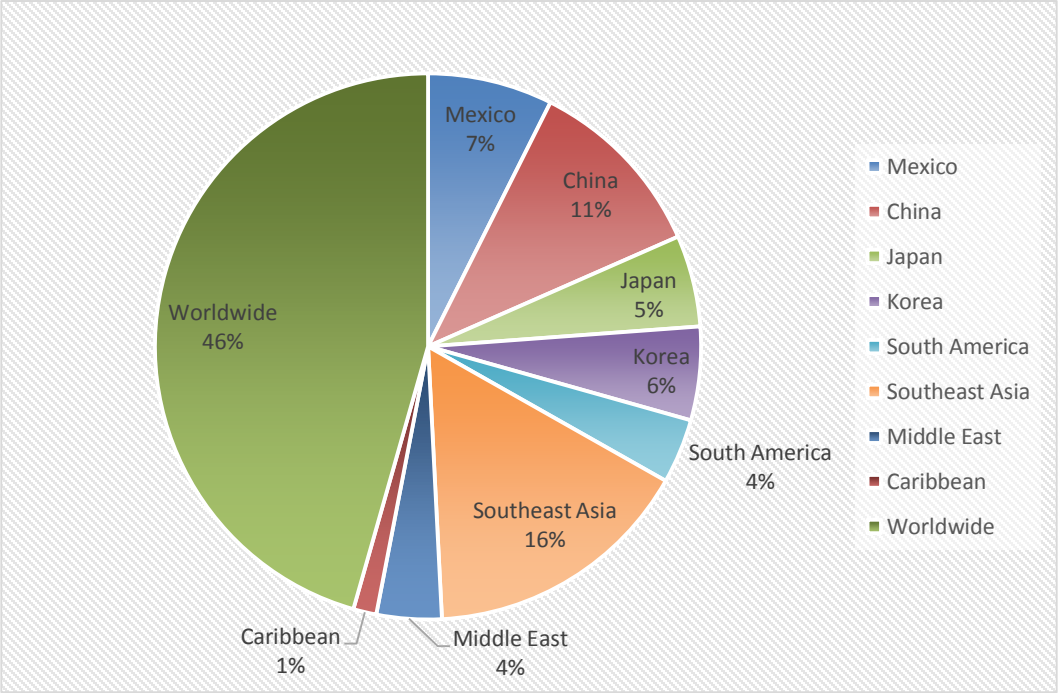

Figure 4: Average Annual FMDP Expenditure by Country

Table 1: Average Annual MAP Expenditure for the Supported Countries and Regions by Activities (in percentage)

Country	Trade Promotion	Consumer Promotion	Technical Assistance	Shows	Int. Travel	STRE	Contract	Others
Mexico	4.01%	46.40%	19.41%	1.09%	1.27%	0.26%	25.24%	2.32%
China	1.72%	7.30%	44.07%	2.33%	2.27%	0.00%	40.65%	1.66%
Japan	0.65%	43.07%	22.42%	0.82%	3.03%	0.00%	28.81%	1.20%
Korea	4.16%	25.86%	27.60%	2.63%	8.76%	0.10%	28.62%	2.27%
Taiwan	4.02%	25.93%	67.29%	2.76%	0.00%	0.00%	0.00%	0.00%
Vietnam	0.00%	0.00%	95.96%	4.04%	0.00%	0.00%	0.00%	0.00%
Southeast Asia	0.00%	0.00%	36.40%	7.74%	11.10%	0.13%	42.85%	1.79%
South America	0.00%	9.02%	35.40%	3.75%	9.10%	0.54%	38.82%	3.36%
EU	0.00%	1.43%	8.93%	6.03%	2.69%	0.00%	77.79%	3.12%
Middle East	0.00%	20.27%	33.91%	10.23%	6.07%	0.00%	27.83%	1.68%
Caribbean	1.85%	16.53%	66.87%	4.29%	2.27%	0.00%	8.19%	0.00%

Table 2: Average Annual FMDP Expenditure for the Supported Countries and Regions by Activities (in percentage)

Country	Technical Assistance	Shows	Int. Travel	STRE
Mexico	57.15%	40.11%	2.38%	0.35%
China	59.29%	10.32%	30.39%	0.00%
Japan	56.24%	27.14%	15.61%	1.01%
Korea	79.84%	0.00%	19.68%	0.48%
Southeast Asia	68.61%	3.64%	27.76%	0.00%
South America	74.70%	9.82%	15.48%	0.00%
Middle East	66.25%	5.58%	28.17%	0.00%
Caribbean	100.00%	0.00%	0.00%	0.00%

3. Agency

The expenditures from FAS represent the government contribution to market development. Government monies provided through the Corporate Program are matched by private expenditures provided by the USDEC and together support the export promotion of U.S. dairy products, while the private contribution has a higher deviation than government support throughout years (Figure 2).

Through the cooperation with the federal government, the USDEC, as an industry representative for export development, has played a significant long-term role in enhancing U.S. global competitiveness and assists the U.S. industry to increase its global exports through various marketing programs. Their primary endeavor is to secure suppliers and processors to meet market needs. Therefore, because they are not limited to conventional marketing activities, they are also involved in market research, trade policy initiatives, policy updates, and documentation. The USDEC is funded primarily by the dairy promotion check-off program, but also receives funds from MAP and FMDPs.

U.S. Dairy Export Market

In response to worldwide competition and the economic dynamics of the global dairy market, U.S. dairy suppliers have been promoting U.S. dairy products for global demand during the past decade. Improved transportation and refrigeration technologies have made dairy trade more economically feasible than in previous years. U.S. dairy exporters experienced substantial growth in exports in recent years: the total dairy export value reached $5.12 billion in 2012, and the record was soon raised to $6 billion in 2013. The average annual rate of change in compounded percentage from 1999 to 2012 was 15%. This was due to the reduced competition

from traditional exporters such as EU and New Zealand, increased demand from emerging markets, increased unit price of protein product and milk powder, and the growing competitiveness of U.S. dairy products (USDA, FAS, 2013). The three largest product groups in value during the period were non-fat dry milk (NFDM) (28.2%), whey (15.6%), and cheese (17.6%) (Figure 5). In 2012, exports equaled 45% of total NFDM/SMP production in the U.S., 47% of the whey, 66% of the lactose, 5.5% of butter and 5.3% of cheese (U.S. Dairy Export Council, 2013).

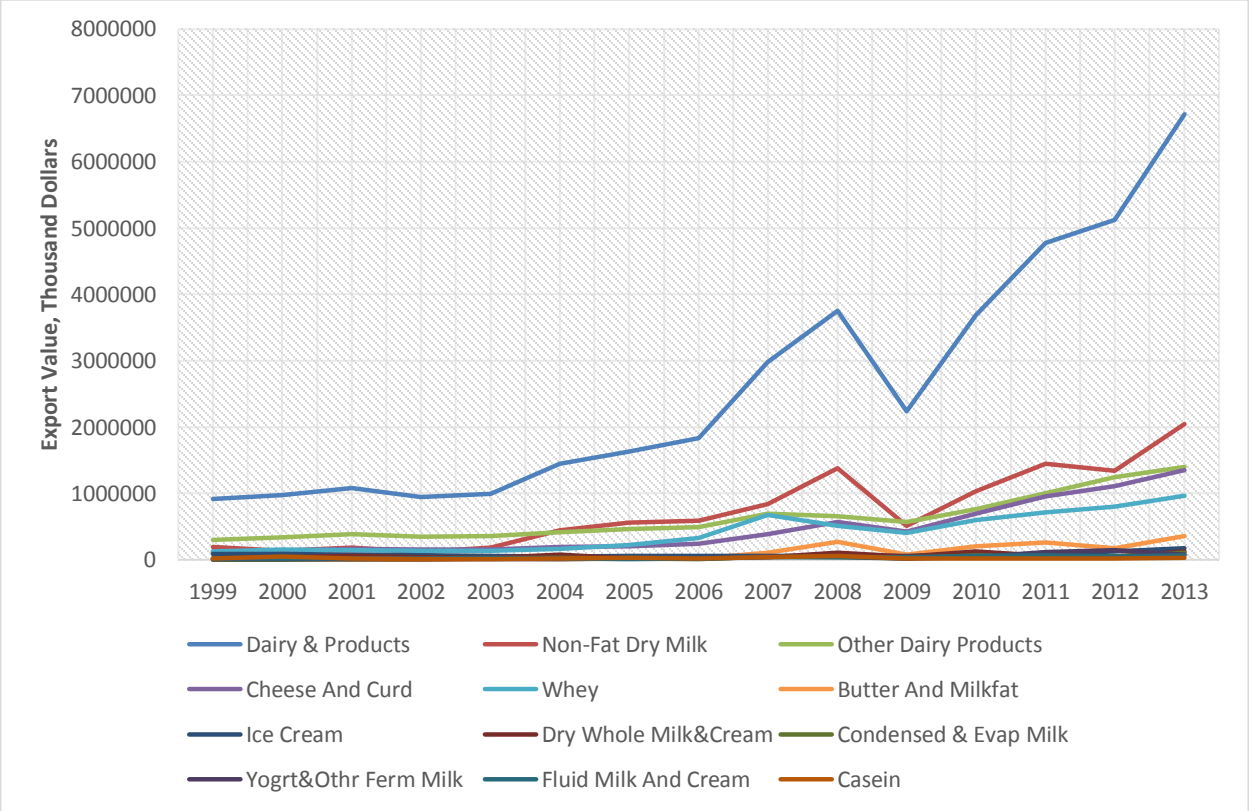

Figure 5: Total U.S. Dairy Exports by Products

Regarding the export promotion program, the supported countries consumed 80% of the total export commodities in 2012 FY. That is up from nearly 72% in 1999 and 2000, which indicates these targeted countries have increased their market share of U.S. dairy imports over this time period; these countries have become increasingly important to the dairy industry (Table 3). Among the program-supported countries, Mexico receives the largest trade flow for dairy products from the U.S., which represents around one-fifth of the total export market. This is not only due to the geographical advantage with the United States, but also the implementation of the North America Free Trade Agreement (NAFTA). In Asian markets, the picture is somewhat mixed. Growing demand for milk in developing countries, such as China and Vietnam, has affected the trade pattern, though per capita consumption of milk is still extremely low. High income countries, such as Japan and Taiwan, have become less important to U.S. dairy exporters over time.

Table 3: U.S. Export Value to a Series of Specific Countries in Percentage of Total U.S. Export

Country	**1999**	**2000**	**2001**	**…**	**2010**	**2011**	**2012**
Mexico	19.21%	17.00%	22.91%	…	22.67%	24.37%	23.96%
China	6.83%	4.99%	5.79%	…	6.80%	8.02%	8.63%
Japan	11.91%	10.75%	9.31%	…	5.52%	5.80%	5.55%
Korea	2.87%	3.40%	4.05%	…	3.54%	4.65%	4.39%
Taiwan	4.73%	4.35%	3.46%	…	0.91%	0.98%	1.09%
Vietnam	0.58%	0.63%	0.90%	…	4.27%	3.92%	2.73%
SE Asia	8.52%	10.30%	10.46%	…	18.89%	20.22%	18.00%
SA	4.57%	6.64%	3.99%	…	3.91%	3.31%	4.98%
EU	4.44%	5.42%	5.57%	…	2.47%	2.57%	1.74%
Middle East	3.30%	3.81%	4.38%	…	4.46%	4.55%	4.85%
Caribbean	5.25%	4.66%	4.36%	…	5.21%	3.88%	4.09%
Total (US Export)	**72.22%**	**71.95%**	**75.17%**		**78.65%**	**82.29%**	**80.02%**

On the other hand, the market share of U.S. dairy products has increased dramatically in the promoted markets during the last decade. In low income countries, like China, the growth in volume share was far larger than the growth in value share (Table 4, Table 5), which means the demand for dairy products was driven primary by imports of low-value-added products. In contrast, in high income regions such as the European Union, the annual growth rate was small, but it was driven primarily by high-value-added products (Blayney, et. al, 2006). In addition, the superiority of U.S. dairy products in the global market and their high volume market share enabled U.S. exporters to take power over pricing in some regions.

The remainder of this thesis is organized into five parts. In the next section, we reviewed previous research on the effectiveness of U.S. export promotion for various commodities. Section 3 describes the data and econometric model, and examines the effectiveness of the program through comprehensive analysis. The fourth section discusses the interpretation of the results and discusses some of the managerial implications. Finally, the last section provides some concluding remarks.

Table 4: Rate of U.S. Dairy Export Value over Total Dairy Import Value in Selected Countries

Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Mexico	36.7%	29.3%	31.8%	31.6%	37.6%	44.9%	48.1%	46.1%	54.1%	66.4%	64.6%	70.0%	73.1%
China	8.8%	6.5%	7.7%	6.7%	6.3%	7.3%	7.1%	10.7%	10.1%	11.0%	7.7%	8.1%	9.5%
Japan	15.6%	15.1%	13.7%	13.3%	11.3%	11.7%	11.6%	12.7%	16.1%	15.5%	13.1%	17.5%	19.2%
Korea	22.6%	24.1%	27.6%	27.4%	29.1%	19.4%	21.6%	23.6%	25.5%	25.0%	23.4%	29.1%	33.0%
Taiwan	19.7%	22.5%	16.1%	13.3%	12.5%	12.4%	10.6%	9.4%	6.8%	8.5%	10.4%	9.9%	10.6%
Vietnam	6.1%	4.3%	4.0%	5.5%	4.7%	17.0%	20.1%	21.4%	14.9%	28.3%	21.7%	32.1%	33.6%
SE Asia	5.4%	6.2%	5.7%	6.1%	5.3%	9.3%	10.5%	13.5%	14.8%	18.4%	10.9%	17.5%	19.4%
SA	5.0%	8.3%	7.1%	6.3%	4.9%	7.4%	7.8%	8.2%	9.1%	5.2%	3.9%	13.2%	10.7%
EU	0.3%	0.4%	0.4%	0.3%	0.2%	0.3%	0.2%	0.3%	0.5%	0.4%	0.2%	0.3%	0.3%
Middle East	1.9%	2.2%	3.0%	1.5%	1.9%	2.2%	1.8%	2.1%	2.8%	4.0%	2.2%	3.9%	4.4%
Caribbean	15.1%	13.2%	12.9%	15.9%	13.1%	26.9%	21.7%	19.2%	18.0%	23.0%	24.9%	36.9%	28.7%

Table 5: Rate of U.S. Dairy Export Quantity over Total Dairy Import Quantity of Selected Countries

Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Mexico	26.8%	23.8%	25.0%	23.3%	27.4%	35.0%	39.0%	41.1%	52.0%	65.5%	56.6%	69.5%	71.5%
China	5.7%	5.8%	8.0%	9.5%	8.8%	10.5%	14.0%	13.9%	13.2%	17.0%	12.2%	15.1%	15.5%
Japan	9.3%	8.0%	7.4%	8.6%	7.3%	11.1%	12.7%	13.8%	13.4%	19.6%	13.9%	18.3%	19.1%
Korea	22.0%	21.9%	28.7%	19.7%	23.7%	17.5%	28.5%	30.9%	31.1%	30.7%	25.8%	35.8%	36.4%
Taiwan	7.1%	9.9%	12.7%	10.7%	14.2%	13.7%	13.5%	11.8%	7.7%	14.1%	9.5%	12.8%	11.8%
Vietnam	11.3%	8.0%	7.2%	13.0%	13.2%	27.1%	40.2%	38.0%	20.3%	39.3%	36.3%	42.4%	43.0%
SE Asia	5.5%	5.4%	5.9%	6.0%	5.5%	9.6%	11.9%	14.8%	14.8%	20.2%	13.2%	21.0%	20.8%
SA	3.1%	5.3%	6.3%	5.3%	3.3%	4.8%	7.5%	7.6%	7.5%	5.9%	3.2%	10.7%	8.4%
EU	0.1%	0.1%	0.1%	0.1%	0.1%	0.2%	0.1%	0.2%	0.5%	0.3%	0.1%	0.2%	0.2%
Middle East	0.8%	1.2%	1.3%	1.2%	1.9%	1.9%	1.4%	1.7%	2.6%	4.4%	2.3%	4.1%	4.6%
Caribbean	12.6%	9.1%	7.8%	6.7%	7.1%	22.1%	15.5%	12.8%	13.6%	21.4%	17.5%	20.8%	21.4%

LITERATURE REVIEW

Export Promotion Programs

There was a comprehensive literature review of export promotion economic evaluations included in an economic evaluation study of all FAS programs prepared by Global Insight Inc. in 2006. According to the report, the majority of the studies focused on one specific commodity in a country or region, and measured the direct or indirect impacts of export promotion programs using various techniques. This review builds upon the Global Insight, Inc. review and focuses primarily on studies conducted since 2006. This review is not exhaustive, but it does contain a representative sample of commodities and techniques used in such evaluations.

1. Individual Commodity Studies

I. Grains

Rusmevichientong and Kaiser (2009) estimated export demand for U.S. rice using a single instrumental-variable regression and annual data from 1984 through 2005. The dependent variable was U.S. rice exports net of other export donation programs. The independent variables included the price of U.S. rice, the export price of competing countries (Thailand and Vietnam), the GDP for major U.S. importers, exchange rates, and U.S. rice export promotion expenditures. The estimated promotion elasticity was 0.21, which indicated that promotion expenditures had a positive and significant impact on rice exporting activities. Through stimulation analysis, they estimated that the average benefit cost ratio ranged from 14.48 for their most inelastic supply assumption to 6.21 for the most elastic one, and the marginal benefit cost ratio ranged from 4.53

to 2.12. These results indicated that the U.S. rice export promotion was highly profitable to the industry and that it was underfunded from an economic optimality viewpoint.

In a related study, Rusmevichientong and Kaiser (2011) examined whether there was a "halo effect" for U.S. grain export promotion on U.S. grains and non-U.S. grains. They used a linear approximation of an Almost Ideal Demand System (LA/AIDS) method, which consists of three major grains: rice, wheat, and sorghum, and two regions (U.S. and non-U.S.). The model estimated both direct and indirect effects using annual data from 1975 to 2005. The dependent variable was export market share, and the independent variables included promotion expenditures, special drawing rights as a proxy for the value of the U.S. dollar, and the world price index. There are three general conclusions drawn from this study. First, the own effects of U.S. export promotion for the three commodities were all positive and statistically significant. The short-run promotion elasticities for rice, wheat, and sorghum were 0.287, 0.186 and 0.148, respectively, and the long-run elasticities were 0.616, 0.205 and 0.269, respectively, which are extremely high compared with other studies. Second, no halo effects of U.S. promotion on other grains were found. Third, U.S. grain export promotion has an anti-halo effect on competing countries' grain exports.

II. Raisins

Kaiser (2010) estimated the effectiveness of each of five raisin export promotion programs operated by the Raisin Administrative Committee (RAC) in 12 importing countries, including Japan, China/Hong Kong, South Korea, Taiwan, Singapore, Thailand, Indonesia, Malaysia, Philippines, United Kingdom, Germany, and Scandinavia. The five export promotion programs examined in this study included the MAP, Industry Market Promotion Fund, Merchandise Incentive Program, general promotion funds from the RAC, and the Export

Replacement Offer program. The study estimated raisin import demand using panel data from the 12 importing regions over the time period, 1996 through 2008. The independent variables in the model included the price of California raisins in each country, the raisin price of competitors, exchange rate, population, consumer income level, and expenditures for each of the five export promotion programs. The overall average promotion elasticity across all programs and all countries was 0.204, which indicated that promotion programs had a positive and statistically significant effect on increasing the demand in other countries. Kaiser (2010) simulated the demand model for two scenarios: (1) with export promotion and (2) without export promotion over the most recent five years and for all countries. He found raisin imports, on average, would have been 66.5% lower if export promotion programs had not existed. He calculated average and marginal BCRs by programs and countries. The overall average BCR for all countries and all programs was 3.49, which indicated a dollar investment in all California raisin export promotion programs and all countries returned $3.49 in additional gross export revenue on average. The average BCR ranged from 1.80 to 25.15 by program, while the average BCR ranged from 0.06 to 5.19 by country. The overall marginal BCR for all countries and all programs was 1.20, which implied a slight underinvestment in these programs.

III. Meat

Henneberry, Mutondo and Brorsen (2009) used an equilibrium displacement model (EDM) to measure the potential impact of U.S. domestic and export promotion programs on the welfare of producers and marketers of U.S. meats, considering both the U.S. participation in the global meat market and the imperfect competition structure of the meat industry. The global meat industry in this study was represented by a system of demand and supply relationships. On the supply side, the authors disaggregated meat supply into three categories (beef, pork and

poultry) and then suppliers by nations. On the demand side, they divided the market system into five destinations (U.S., Canada, Japan, Mexico, and South Korea) and then put them into source-differentiated categories. As a result, 57 price linkage equations and 25 quantity linkage equations were included in the EDM. The authors simulated the EDM under two hypothetical scenarios: (1) higher advertising elasticity, (2) lower advertising elasticity. Each scenario assumed a different value for promotion-induced demand shifters. Note that the elasticities were taken from the previous studies that had measured beef and pork advertising elasticities. Welfare impacts at the farm- and retail- levels were calculated under imperfectly competitive and perfectly competitive market structure in each scenario. They observed that a 10 % increase in the promotion range could increase the U.S. producer welfare ranges from -$1.29 million to $2.60 million for beef producers, and from -$0.96 million to $1.67 million for pork producers. The results indicated that the impact of meat promotion varies with the scenarios and the market structure, and depends primarily on the advertising elasticity.

IV. Soybeans

Williams, Capps and Bessler (2009) investigated the effects of the soybean check-off program on demand, supply, price, and trade of soybeans, soybean meals, and soybean oil in six main trading regions, including the U.S., Brazil, Argentina, the EU, Japan, and the rest of the world, from 1980/81 through 2006/07. The main tool in analysis was a fifth generation price equilibrium annual econometric simulation model of the world soybean and soybean product markets (SOYMOD5), which contains 180-equations. The model was then simulated over the same period under alternative assumptions regarding soybean check-off research and demand and international market promotion expenditure levels. Through analyzing different check-off expenditure scenarios, the authors concluded that promotion had effectively increased U.S.

soybean production, exports, price, world market share, and producer profits. The net profit BCR for the entire program was calculated to be 6.4, and even when the net benefits were discounted to present value, the BCR was still 2.4, which indicated that the economic profits generated by additional investment in soybean check-off programs far exceeded the additional expense for implementation of the national program over that period. Therefore, the authors concluded that the U.S. soybean industry has underinvested in the check-off program. However, this study did not analyze the effects of international promotion expenditures independently, because such an analysis would have ignored the synergistic effect from production research and domestic market promotion.

Williams (2012) revisited the 2009 study and provided more details on the effects of the soybean check-off program on international market exports, assuming other promotions were on-going at the same time. Specifically, the author separated the check-off program into three components: product research, domestic promotion, and international promotion. Then, he constructed them as variables in the related equations of SOYMOD5 and ran a similar simulation under the two scenarios the previous study had conducted. The study found that the gross export revenue BCR was 29.6, and the net profit from export promotion had a BCR of 9.2. Both of these estimates were higher than the previous study had found. In conclusion, the benefits from export promotion far exceed the costs, and the return for one dollar spent on international promotion has been larger than the return per dollar spent on the overall soybean check-off program.

V. Dairy

Similar to the purpose of the present study, Olukoya (2008) estimated the direct and indirect effectiveness of dairy export promotion expenditures on selected U.S. dairy products

(whey, cheese, and Non-fat Dry Milk [NFDM)) in selected countries using different demand specifications based on the multistage budgeting approach. Mexico, South Korea and Thailand were selected for U.S. whey import demand; Mexico, South Korea and Japan were selected for U.S. cheese import demand; and Mexico, Thailand and Japan were selected for U.S. NFDM import demand. For each country, the author specified its import demand in a system that consisted of a variety of countries as comparisons.

The analysis consisted of three main parts. The authors first conducted a nested test among alternative theoretical econometrics models, such as the Rotterdam model, AIDS model, the Central Bureau of Statistic (CBS) model, the National Bureau of Research (NBR) model, and the general model to select an appropriate model for U.S. dairy export promotion for each commodity in each of the destinations. Based on the results of the test, the Rotterdam demand system model was selected to estimate the import demand for cheese and NFDM in Japan, whey and NFDM in Thailand, cheese in South Korea, and whey in Mexico, while the CBS was used to measure the demand for cheese and whey in South Korea and cheese and whey in Mexico. Secondly, the author implemented the models with quarterly trade value data from 1st quarter of 1998 to 4th quarter of 2005 to estimate the expenditure, promotion and price elasticities, as well as the complementary relationship among different sources. Estimations were made for each U.S. dairy commodity in each country in a source differentiated demand system. Finally, the author calculated the marginal returns to promotion expenditure on import demand with elasticities they found from the econometric model. The estimation results varied by country and commodity, while the U.S. promotion activities for dairy products were not effective in this study. The author speculated that this result may have been due to an insufficient number of observations.

2. Aggregate-level Studies

Kaiser et. al (2010) revisited the impact of the increased market development expenditures on the U.S. export during the period 2002-2009 by conducting a series of comprehensive analyses based on the 2006 study. In part of this study, the authors used an Armington trade model to determine both the short and long-term effect of market promotion. Besides the impact of MAP and FMD on U.S. exports, several other factors were included in the analysis, such as exchange rates, trend variable, and a binary variable to account for the negative impact of 2003 and 2006 Bovine Spongiform Encephalopathy (BSE) and avian influenza (AI) on high value product trade. They found that the link between spending for market development and U.S. agricultural trade was more significant than that found in their previous report. The promotion elasticity was 0.186 for high value products and 0.192 for bulk commodities, while both high value and bulk products saw returns far beyond the original year of investment. Under the full employment assumption, the total economic welfare to government expenditure ratio was estimated to be 14.6:1, and 6.7:1 welfare benefit to aggregate promotion expenditure. U.S. net economic benefit increased $1.1 billion for the entire economy. They also updated the "halo" impact of the MAP and FMD programs on other non-promoted commodities, and found the cross promotion elasticities to be mainly positive, indicating some halo effect. In addition, they also simulated the results based on two forward looking scenario assumptions, a baseline scenario and a 50% decrease in funding, and calculated the benefit cost ratio on a broader U.S. economy base. They found the net economic losses to the total U.S. economy from reduced market promotion would average $1.1 billion annually from 2012 through 2018. Consumers abroad would suffer an average $2.1 billion losses in economic welfare due to marginally higher food cost.

Kinnucan and Cai (2010) argued that the subsidies from export promotion programs may erode the overall welfare of the society, taking into account the welfare loss from domestic consumers. There were two insights behind their argument. First, the export promotion subsidy from the USDA increases product prices in the domestic market by reducing supply from U.S. to foreign countries. Second, the export promotion subsidy reduces demand in domestic market because industry-sponsored promotion expenditures are diverted from the domestic market to the export market. Specifically, their result indicated that a 1% increase in government expenditures in export promotion would reduce expenditures for domestic market promotion by 0.3%. Therefore, the authors discussed two conditions in terms of the marginal BCR: (1) when there was no cannibalization effect, the producer marginal BCR was 39:1 and the national marginal BCR was 10:1; and (2) when there was a cannibalization effect, the producer marginal BCR declined, but was still positive, while the national marginal BCR was estimated between -30:1 and 7:1.

In 2014, Kinnucan and Gong obtained similar results by estimating consumer demand and advertising-goodwill reallocations using time series data from 1975-2008. They adopted three different government expenditure scenarios and used linear model, semi-linear model, and log-log model to estimate the industry expenditure function for advertising. Three of nine equations showed an inverse relationship between industry expenditure and government expenditure, while the remaining six showed no relationship.

METHODOLOGY AND DATA

Methodology

In this study, we evaluate the effectiveness of the U.S. Dairy export promotion program (MAP and FMD). The analysis is based on two econometric models: (1) import demand model, and (2) Armington model. These two models are estimated and then used to simulate several in-sample scenarios involving alternative funding levels for export promotion to calculate BCRs for the programs. This section discusses the models and data in detail.

1. Import Demand Model

An import demand equation is used to quantify the economic relation between market promotion and U.S. dairy imports for various countries. The key determinants include the price of U.S. dairy products in the importing countries, price of dairy products from other dairy exporting nations, U.S. exchange rate, and gross domestic product per capita of the importing countries. The price of dairy products from both the U.S. and the foreign market are deflated by dividing by the consumer price index (CPI) in the importing country to net out the effect of inflation over time. The general form of the aggregate dairy import demand equation is:

$$\sum_{n} Q_{us,i,t,n} = f\left(\frac{P_{us,i,t}}{CPI_{i,t}}, \frac{P_{non,i,t}}{CPI_{i,t}}, \frac{GDP_{i,t}}{POP_{i,t}}, RER_{i,t}, \frac{EXP_{i,t}}{CPI_{i,t}}\right)$$

In this equation, $Q_{us,it,n}$ represents the U.S. dairy import for commodity n (there are nine dairy products[7] included in this study) to country i in year t. The import quantity is summed up

[7] The nine products include: cheese, NFDM, whey, butter, fluid milk, yogurt, dry whole milk, ice-cream, and condensed milk.

on a milk equivalent basis[8]. P_{us} is the price (unit value) of dairy product imports from the U.S. and P_{non} is the price (unit value) of dairy product imports to region i from the rest of the world. GDP is gross domestic product. POP refers to population. RER represents the real, inflation-adjusted exchange rate for the U.S. dollar. EXP measures the market development program (MAP/FMD) expenditures (in $1,000) from both FAS and the cooperator. The model is estimated in double logarithmic form. Further, we use an instrumental variable for the U.S. product price in the equation to deal with the possible price endogeneity problem. This variable is the predicted value from a regression of the U.S. price on the exogenous variables in the import demand model. Several panel data estimation methods are applied in the statistical regression.

In addition to looking at all dairy product exports in milk equivalent form, we also estimate individual import demand equations for NFDM, cheese, and whey because they are the most promoted commodities of all U.S. dairy products and they comprised the largest proportion of the total dairy export value during the period of study. Another reason for including the individual product models is because the detailed product pattern to these selected markets are different to each other. For example, Southeast Asia imported 4.6 billion pounds of dairy products from the U.S. in 2011, in which 59.5% was NFDM, while in the same year Japan imported 1.2 billion pounds from the U.S., only 10.5% of which was NFDM. Each product import demand equation follows a similar specification as the aggregate demand equation:

$$Q_{us,i,t,n} = f\left(\frac{P_{us,i,t,n}}{CPI_{i,t}}, \frac{P_{non,i,t,n}}{CPI_{i,t}}, \frac{GDP_{i,t}}{POP_{i,t}}, RER_{i,t}, \frac{EXP_{i,t,n}}{CPI_{i,t}}\right)$$

[8] The equivalent pounds of whole milk containing a specific percentage of milk fat--usually 3.67 %--used in the production of manufactured dairy products. One method for computing milk equivalent is to multiply the volume of specific manufactured dairy products by a conversion factor derived from the yield of the product from a hundredweight of milk at the specified milk fat percent and milk solid percent. In this case the conventional factor calculated in a 40/60 weighting scheme (40% of milk fat weight plus 60% of solid-non-fat weight) (Jacobson, 1992).

where n denotes NFDM, whey, or cheese.

2. Armington Model

We also adopt an Armington-type market share model (Dwyer, 1995) to analyze whether a dairy export promotion program increases market share of U.S. dairy products in foreign markets among other exporters. The general form of the model is the following:

$$\ln(MS_{i,t}) = \beta_0 + \beta_1 \ln(MS_{i,t-1}) + \beta_3 \ln(RER_{i,t}) + \beta_4 \ln(T_i) + \beta_5 \ln(EXP_{i,t}) + \varepsilon$$

where MS_{it} represents the market share of aggregated U.S. dairy product in the i[th] region in year t. T is the trend variable, and EXP is U.S. export promotion for dairy product i. The lagged market share should be positively related to the market share in the previous year, because importing firms in other regions gradually adjust their purchase in response to changes in price, promotion, and exchange rate overtime, considering the uncertainty in the market. (Dwyer, 1995). Thus, we include this variable to measure the partial adjustments over time to compute the long-run response of the market. The Armington model is one kind of partial adjustment model that allows us to calculate both the short-run effects of a promotion program and the long-run promotion effects. For example, a 1% increase in expenditures in year t will increase the market share in the same year by β_5 percent; in period t+1 the market share will continue to increase by $\beta_1\beta_5$, because past market share has a positive effect; in period t+2, we will have another effect on market share by $\beta_1^2\beta_5$. Consequently, the aggregate long-run effects of altering export promotion is equal to $\frac{\beta_5}{(1-\beta_1)}$ (LaFrance and Burt, 1983).

3. Simulation

We simulate the econometric results from the import demand equation based on three scenarios. In the first scenario, which is the baseline for the analysis, we assume that the MAP and FMDP expenditures remained at historical levels. In the second scenario, we simulate dairy promotion at 5% of historical expenditure levels. The difference between these two scenarios indicates the overall impact of the dairy market development program on U.S. dairy export. Then, to compute a marginal BCR, we simulate a third scenario where export promotion expenditures are increased by 10% above historical levels.

4. Benefit-Cost Analysis

To address the question whether returns from U.S. dairy export promotion exceed the costs, we calculated average and marginal BCRs for the program. The average BCR measures the return on all dollars expended on the program, while the marginal BCR measures the return on the last dollar spent on the program. The theoretical support behind this analysis is based on a conceptual model of supply and demand where the increase of promotion would induce demand shifting and the increase in price at the industrial level, because the supply curve is not perfectly elastic (Alston, et. al, 1997).

In order to conduct the average benefit-cost analysis, we employed the producer surplus method from previous studies (Alston, et. al, 1997; Rusmevichientong and Kaiser, 2009), which combines the export demand model with an assumed supply response elasticity. First, from the demand side, we utilized the simulation result from the baseline scenario and defined the fitted value as Q_t^D. Second, we generated an export supply function in constant elasticity form, and

assumed it could pass through the predicted export quantity from the demand side. Hence, the export supply function is:

$$Q_t^S = A_t P_t^{\varepsilon}$$

where $A_t \equiv \frac{Q_t^D}{P_t^{\varepsilon}}$. P_t represents the price of U.S. dairy products ($/lb.) in year t. ε is the price elasticity of export supply, which could be relatively elastic because it was the excess supply of the dairy. A_t is a parameter varied from year to year to ensure that each year the export supply equation passes through the predicted quantity defined by the import demand model and the actual price of dairy products. The export supply function was calibrated using alternative export supply elasticities options. Producer surplus was calculated by integrating the export supply function over the range of a price change:

$$\Delta PS = \frac{P_t Q_t - P_t' Q_t'}{1 + \varepsilon}$$

where $P_t Q_t$ represented the baseline scenario and $P_t' Q_t'$ represented the second scenario (without the export promotion). For the marginal benefit cost ratio calculation, the theory is similar, except that $P_t Q_t$ would be the third scenario (incremental export promotion) and $P_t' Q_t'$ would be the baseline scenario for comparison.

Data

The data come from four sources: (1) macroeconomics variables for the importing countries from USDA, ERS, such as real exchange rates, GDP, etc. (2) export promotion program expenditures from USDEC, (3) U.S. Dairy Export from FAS, and (4) targeted market dairy import quantities and values from FAO, extended from 1999 to 2012.

Table 6: Data Used in Import Demand Model

Variable	Definition	Units	Data Source
$P_{us,i,t,n}$	Average unit value of U.S. dairy export for commodity n to country/region i in year t	Real (2005) dollar per pound	U.S. Census Bureau Trade Data. Foreign Agricultural Service, Global Agricultural Trade System
$P_{non,i,t,n}$	Average unit value of dairy import for commodity n to country/region i in year t from the rest of the world	Real (2005) dollar per pound	Food and Agricultural Organization of United Nation, trade module for crops and livestock products
$Q_{us,i,t,n}$	U.S. dairy import for commodity n to country/region i in year t	Pounds	U.S. Census Bureau Trade Data. Foreign Agricultural Service, Global Agricultural Trade System. Converted to milk equivalent quantity using total solid method
$CPI_{i,t}$	Historical Consumer Price Index for country/region i in year t	Real CPI indice (2005=100) in percent	International Financial Statistics, International Monetary Fund and ERS Baseline Regional Aggregations
$GDP_{i,t}$	Real Historical Gross Domestic Product (GDP) for country/region i in year t	Real billion of 2005 dollars	World Bank World Development Indicators, International Financial Statistics of the IMF, IHS Global Insight, and Oxford Economic Forecasting
$POP_{i,t}$	Total population in country/region i in year t	Unit	U.S. Census Bureau, International Data Base
$RER_{i,t}$	Real Historical Exchange Rates for country/region i in year t	U.S. dollars/ the other currency	Calculated from nominal exchange rates and CPIs
$EXP_{i,t}$	Total dairy export promotion expenditures for country/region i in year t	Thousand U.S. dollars	USDEC MAP and FMD budget and expense summary

The international macroeconomic dataset was downloaded from USDA, Economic Research Service, which provided data from 1969 to 2030 for real (adjusted for inflation) Gross Domestic Product (GDP), population, real exchange rate, and other key economic variables for 190 countries and 34 regions that are most important to U.S. agricultural trade.

Export promotion expenditures came from the USDEC, which included MAP and FMD expenditures from both USDA and private cooperators. The U.S. dairy exporters focused on 10 specific countries and regions including Mexico, China, Japan, Korea, Taiwan, South America, Caribbean, Southeast Asia, Middle East, and EU.

The U.S. dairy export value (in 2000 dollars) and quantity (in tons) were taken from the Global Agriculture Trade System (GATS) in the USDA. We also collected detailed dairy export product combinations for each country and region, and then converted the export quantity from product basis to milk equivalent basis based on the total solid method (in lbs). Finally, we collected dairy import data for the countries and regions mentioned above from Food and Agriculture Organization (FAO), and converted the import quantity into a milk equivalent basis as well. We combined these four sources together in an aggregate panel dataset from 1999 to 2011 across 10 countries and regions. The panel data allow us to control variables that we cannot observe or measure, such as different cultures of dairy consumption among nations.

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RESULTS AND ANALYSIS

Aggregate Dairy Product Analysis

1. *Econometrics Results*

To estimate the effectiveness of market development programs on the aggregated import demand across 10 targeted regions over the period from 1999 to 2012, we used several regression models to quantify the elasticities. The results are presented in table 7.

The econometric model presented in this table is an import demand model estimated by the most commonly used methods: the fixed effects and the random effects technique. The Hausman test indicates that characteristics within each region may impact or bias the prediction and we need to use the fixed effects technique to control for this. Because price is potentially endogenous in the demand model, we conduct instrumental variable regression and insert the lagged price as an exogenous variable, because the price is relatively sticky overtime (Dwyer, 1995). Both the Hausman test and the original fixed effect model (OLS) is consistent. In addition, a variance inflation factor (VIF) is employed to test for multicollinearity among independent variables. In this study, the VIF was 1.56, far below the general rule of thumb VIF exceeding 4. However, other post estimation tests suggest the fixed effect might not be able to produce robust standard errors. The modified Wald test for group-wise heteroskedasticity presentes a heteroskedasticity problem in the fixed effect regression model. Also, the Wooldridge test for autocorrelation suggests there exists a first order autocorrelation. Moreover, the Pasaran CD (cross sectional dependence) test is used to test whether the residuals are correlated across entities (countries), and the violation is evident based on a significant low p-value.

To avoid certain violations of the underlying econometric model, we considered the cross-sectional time-series Feasible Generalized Least Squares (FGLS) regression and the linear regression with panel-correlated standard error (PCSE). The theoretical assumptions of these two methods are similar. Both of them assume an exponential correlation. They estimate parameters of the covariance matrix using maximum likelihood and estimate the regression coefficients by Weighted Least Squares (WLS). As presented in the table, the coefficients between the two models are similar, while the standard errors of the FGLS are smaller than those of PCSE. This result is similar to previous findings (Beck and Katz, 1995), where the authors argued that FGLS would produce more efficient estimates of the parameters, with the disadvantage that the standard error estimators are conditional on the estimated disturbance covariance and probably are not optimal. However, we would like to interpret the estimations from FGLS as our final result, because we need to utilize the more efficient estimators to generate simulation analysis. The method is feasible here because the time dimension T is greater than the cross-sectional

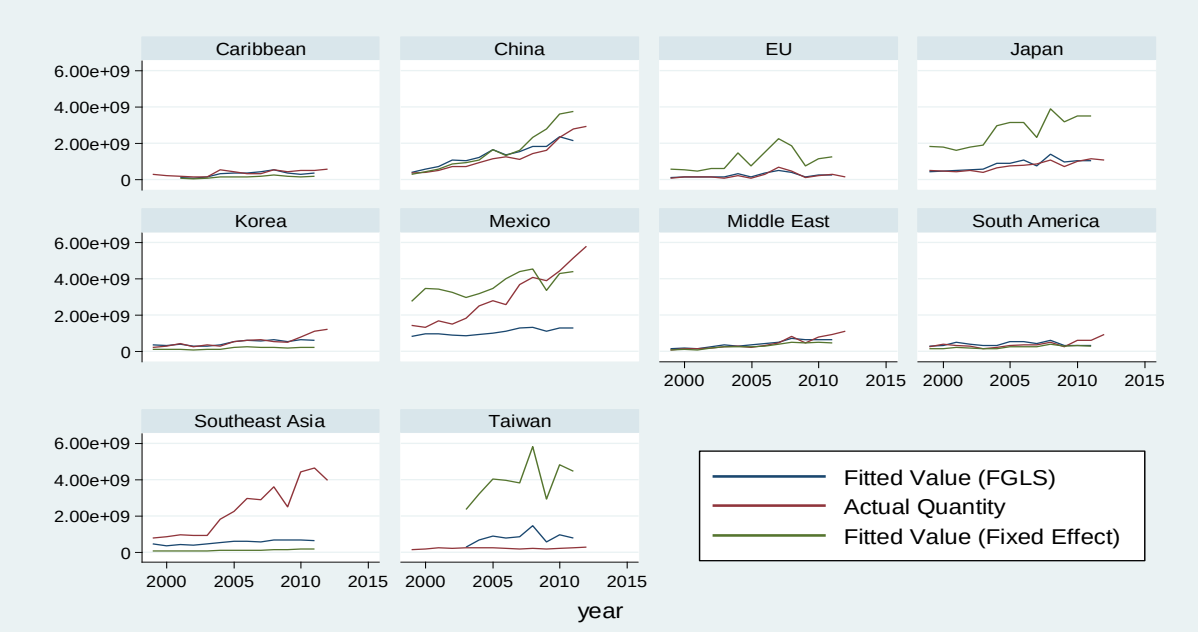

Figure 6: Comparison between Fitted Value and Actual Quantity

dimension N. In fact, the FGLS and PCSE estimators fit the actual values better than the fixed effect model (Figure 6). The RMSE is 0.696. The estimated import demand model for U.S. dairy products is

$$\ln(Q_{i,t}) = \underset{(12.95)}{20.92} + \underset{(2.32)}{0.165}\ln(GDPpp_{i,t}) - \underset{(10.14)}{1.028}\ln(P_{us,it}) + \underset{(7.56)}{1.251}\ln(P_{non,it}) + \underset{(5.86)}{0.298}\ln(EXP_{i,t}) + \underset{(4.31)}{0.225}\ln(RER_{i,t})$$

The regression estimators indicate that the market development programs and promotion efforts have had a statistically significant effect on total dairy export quantity to these targeted markets over the study period. The overall elasticity of the program is 0.298, which means that if we increased the expenditure by 1%, we would expect the total export demand to increase by 0.298 %. This promotion elasticity is relatively higher than ones in other export promotion studies. Moreover, as expected, an increase in GDP per capita in the importing countries is associated with an increase in export demand. An increase in the real exchange rate (other currencies/dollars) would stimulate supporting regions to import more U.S. dairy products, since these products would be relatively cheaper in this case. Coefficients for the price of U.S. dairy exports in each importing region and the price of dairy products of competing export countries in each importing region have the correct sign as expected, and both of them have an absolute value greater than 1. These results indicate that importers are highly sensitive to the prices of U.S. dairy exports and to prices of competing countries in the import decisions.

2. Market Share

We also adopted the Armington model to examine how U.S. market share of dairy products in foreign markets was influenced by market development promotions. Similar to the process above, we use the fixed effects and the random effects methods to estimate the

parameters. Based on the Hausman test, we concluded that the random effects method was not appropriate. Because other tests suggest that problems with heteroskedasticity, first-order autocorrelation, and contemporaneous correlation across panels, we employ FGLS (3) and PCSE (4) as a more appropriate method for estimating the model parameters. The estimated Armington model is:

$$\ln(MS_{it}) = \underset{}{-0.165} + \underset{(0.70)}{0.959}\ln(MS_{i,t-1}) + \underset{(41.86)}{0.007}\ln(RER_{i,t}) + \underset{(0.64)}{0.031}\ln(T_i) + \underset{(1.17)}{0.021}\ln(EXP_{i,t})$$
$$(0.71)$$

Most coefficients in the original model are statistically insignificant, except for the coefficient on lagged market share. However, when lagged market share is omitted from the regression as an independent variable, export promotion and exchange rate become significant in increasing market share in the foreign market. Whereas, omitting one significant variable is misguided due to the theory of the partial adjustment model, is expected. Hence, we interpret the results from FGLS to indicate that a 1% increase in export promotion expenditures would bring about a 0.021 % increase in the U.S. dairy export market share in the short run, and a 0.51 % increase in the long run. The result suggests that the dairy promotion activities may not have a strong impact on market share in the short run, but the effect may accumulate over time and become significant in the long run.

3. Simulation

According to the econometric results of the export demand model, it is clear that the dairy market development program has had a positive and statistically significant effect on U.S. dairy exports to the target markets. Next, we are interested in by how much the promotion expenditures have increased total U.S. dairy exports in each target country over the past decade.

Based on the PSCE with IV regression, a baseline scenario is simulated within the sample by setting all exogenous variables, including export promotion expenditures, to historical levels. Comparing the predicted value of exports to actual exports, the estimated model is reasonable in predicting actual import demand for most of the targeted regions, except for underestimating the exports to Mexico and Southeast Asia (Figure 6). A second, counter-factual scenario is simulated where all exogenous variables are set to historical levels except for export promotion expenditures, which are set to 5% of historical levels. We used 5% instead of 0%, because this is a double logarithmic model and the log of zero is undefined. The difference between the two scenarios indicates the overall impact of market development programs on dairy exports to foreign countries.

The model is simulated over the most recent six-year period from 2006 to 2011 for each market. Figure 7 illustrates the simulation results on the quantity of exports in milk equivalent basis (lbs). It is clear from this figure that the market development programs have a positive

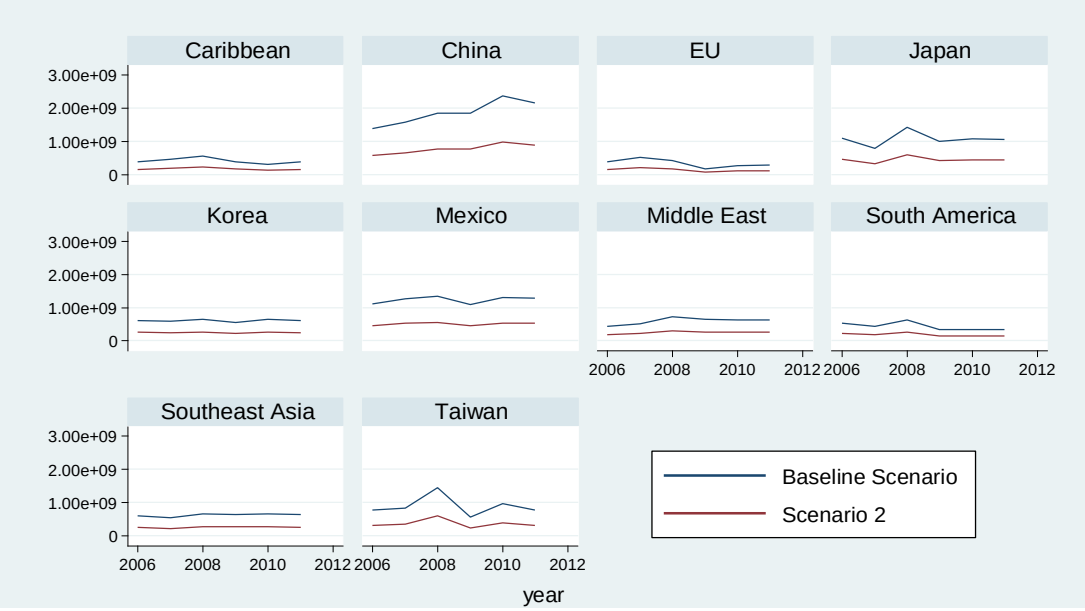

Figure 7: Comparison between Scenario 1 and 2

effect on U.S. dairy exports to most of the countries. We find that during the period, export promotion has stimulated total dairy exports by 28.5 billion pounds, or an average of 475 million pounds per year. In other words, if there was no export promotion over this period, U.S. dairy exports would have been about 59% lower than they actually were. Therefore, we conclude that the U.S dairy market development program has had a significant impact on U.S. exports.

4. Benefit-Cost Analysis

In the previous section, it was shown that the market development expenditures had a substantial impact on increasing U.S. exports and market share for U.S. dairy products. However, promotion not only increases demand, but also increases the price as long as the supply curve is not perfectly elastic. To measure the benefits of export promotion, one needs to incorporate the supply response of U.S. exporters in addition to the demand response from the promotion. To do so, we develop a simulation model that measures the increase in producer surplus to estimate both the average and marginal BCRs as discussed previously. The export supply function is calibrated using alternative own-price elasticity for export supply that range from 2 to 8 in increments of 1. Because the econometric estimation of import demand price elasticity is greater than 1 in absolute value, we believe that this is a plausible range for the actual export supply elasticity.

I. Average Benefit Cost Ratios

The average BCR is useful because it provides a measure of the return in dollars to the U.S. dairy producers for every dollar invested in export promotion. Table 7 shows the annual average BCRs for each assumed supply elasticity due to the U.S. dairy market development program. The ratios are considerably larger than 1.0, indicating that the benefit of market

development in foreign markets in terms of expanding producer surplus is far greater than the annual cost of this program. Because the price in the import demand equation is the price paid to the importer not the price paid to a dairy farmer, we adjusted the price producer surplus formula using the following procedure. The average import price from 1999-2011 for all countries in the sample was $0.20 per pound. The average price received by U.S. dairy farmers over the same period was $0.1473 per pound. Therefore, to convert producer surplus into dairy farmer revenue, the import price was multiplied by 0.737 which is based on the ratio of the average price of farm to import price. As illustrated in Table 7, the average increase in price ranges from $52.06 per thousand pounds of dairy export for the most inelastic supply response ($\varepsilon = 2$) to $15.26 per thousand pounds for the most elastic supply assumption ($\varepsilon = 8$). The positive price impact declines as the elasticity of the assumed supply function became larger, because producers are capable of adjusting the export quantity across the borders in response to the increasing export demand under the flatter supply curve. At the mid-point elasticity ($\varepsilon = 5$), the incremental price was $23.64 per thousand pounds, which means the market development program had increased the price of dairy exports by 19.5% above the original level.

Table 7: Annual Average Benefit Cost Ratio for U.S. Dairy Market Development Program 1999-2011

	Own-price elasticity of Export Supply						
	2	3	4	5	6	7	8
Change in producer price ($/1000'lb)	52.06	37.22	28.92	23.64	19.99	17.30	15.26
Change in producer surplus (million $)	179.61	127.03	98.19	80.00	67.50	58.37	51.41
Change in promotion cost (million $)	6.28	6.28	6.28	6.28	6.28	6.28	6.28
Benefit-cost Ratio	28.60	20.23	15.64	12.74	10.75	9.29	8.19

The increase in producer surplus due to export promotion follows a similar pattern to that of the change in price. The average annual increase in producer surplus ranges from $179.61 million ($\varepsilon = 2$) to $51.41 million ($\varepsilon = 8$). For example, at the mid-point ($\varepsilon = 5$), the increase in

average producer surplus is $80 million, which means that U.S. dairy producers have benefited by more than $100 million annually from export promotion programs during this period. The corresponding average BCR is 12.74 for the case of the mid-point elasticity, which implies that on average the benefits generated by market development programs are 12.74 times greater than program expenditures. Furthermore, we also calculated the lower bound of 95% confidence interval of average BCRs due to the promotion program from 1999 to 2011 (Table 8). The lower bound average BCRs range from 25.91 ($\varepsilon = 2$) to 7.42 ($\varepsilon = 8$), which provides us 95% credibility that the actual average BCR is no lower than the lower bound. Therefore, the program is proven to be effective not only in enhancing foreign demand, but also in improving the social welfare of U.S. dairy producers.

Table 8: Lower Bounds of 95% Confidence Interval for Average Benefit Cost Ratio Due to U.S. Dairy Market Development Program 1999-2011

	Own-price elasticity of Export Supply						
	2	3	4	5	6	7	8
Change in producer surplus Lower Bound	162.70	115.07	88.94	72.47	61.14	52.87	46.57
Benefit-cost Ratio Lower Bound	25.91	18.32	14.16	11.54	9.74	8.42	7.42

For each individual country and region (Table 9), the average BCRs range from 22.18, under the most inelastic assumption, to 4.87, under the most elastic one. The average BCRs for the Caribbean, China, EU, Mexico, Middle East, and Taiwan were above the overall average for all countries, indicating each dollar invested in these markets generated more benefits than other countries. Among these, the EU and Taiwan had the highest average BCRs. Thus, the return per dollar might be higher for EU and Taiwan than the remaining countries.

Table 9: Annual Average Benefit Cost Ratio due to U.S. Dairy Market Development Program 1999-2011, by Markets

	Own-price elasticity of Export Supply						
Country (ABCR)	2	3	4	5	6	7	8
Caribbean	36.33	23.85	19.86	16.18	13.65	11.80	10.40
China	32.86	23.24	17.96	14.64	12.35	10.68	9.41
EU	77.49	54.80	42.36	34.52	29.12	25.18	22.18
Japan	25.68	18.16	14.04	11.44	9.65	8.35	7.35
Korea	17.01	12.03	9.30	7.58	6.40	5.53	4.87
Mexico	30.84	21.81	16.85	13.73	11.59	10.02	8.83
Middle East	41.78	29.54	22.85	18.59	15.70	13.58	11.96
South America	37.71	26.66	20.61	16.80	14.17	12.26	6.59
Southeast Asia	18.48	13.07	10.10	8.23	6.94	6.01	5.30
Taiwan	64.52	45.62	35.26	28.72	24.23	20.95	18.45

II. Marginal Benefit Cost Ratios

The marginal BCRs help to explore whether the U.S. dairy industry's investment in export activities is optimal or not. A marginal BCR less than 1 indicates too much money is being invested in export promotion, and a marginal BCR greater than 1 indicates too little is being invested. To calculate the marginal BCR, we employed a third simulation scenario where export promotion expenditures were increased by a small amount (10% increase) more than historical levels. The difference between the third scenario and the baseline measures the marginal impact of an incremental promotion expenditure on U.S. dairy exports. Then, we replicated the process for generating the average BCRs above, with the marginal costs were equal to 10% of deflated historical export promotion expenditures.

Table 10: Marginal Benefit Cost Ratio Due to Market Development Program 1999-2011

	Own-price elasticity of Export Supply						
	2	3	4	5	6	7	8
Change in producer price ($/1000'lb.)	2.06	1.38	1.03	0.83	0.69	0.59	0.52
Change in producer surplus (million $)	10.59	7.04	5.28	4.22	3.51	3.01	2.63
Change in promotion cost (million $)	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Benefit-cost Ratio	15.13	10.06	7.54	6.02	5.02	4.30	3.76

Table 11: Lower Bounds of 95% Confidence Interval for Marginal Benefit Cost Ratio Due to U.S. Dairy Market Development Program 1999-2011

	Own-price elasticity of Export Supply						
	2	3	4	5	6	7	8
Change in producer surplus Lower Bound	9.59	6.38	4.78	3.82	3.18	2.73	2.38
Benefit-cost Ratio Lower Bound	13.70	9.11	6.83	5.46	4.55	3.89	3.41

Table 10 presents the estimated marginal BCRs under different assumed export supply elasticities. All these ratios are greater than 1.0, indicating under-investment in promotion from an optimality point of view. At the mid-point elasticity ($\varepsilon = 5$), the marginal BCR is 8.57, which indicates that if the FAS and USDEC have an additional $1 to invest in the market development program, the export revenue would increase by $8.57. The lower bound marginal BCRs range from 18.59 ($\varepsilon = 2$) to 4.62 ($\varepsilon = 8$), which yields 95% credibility that the actual marginal BCR is no lower than the lower bound. .

For individual countries and regions, the results were similar to the average BCRs (Table 13). The countries with the highest marginal BCRs were EU, Taiwan, and the Middle East, while those with the lowest were Korea, Japan, and Southeast Asia. It would therefore be profitable to the dairy industry to consider reallocating export promotion funds from East Asia to Europe, the Middle East and Taiwan.

Table 12: Marginal Benefit Cost Ratio due to U.S. Dairy Market Development Program 1999-2011, by Markets

	Own-price elasticity of Export Supply						
Country (MBCR)	2	3	4	5	6	7	8
Caribbean	25.14	16.69	12.55	10.03	8.36	7.15	6.29
China	18.33	12.23	9.12	7.37	6.08	5.25	4.58
EU	47.71	31.98	24.05	19.01	15.94	13.58	11.64
Japan	14.61	9.70	7.31	5.82	4.85	4.14	3.62
Korea	9.86	6.54	4.88	3.93	3.32	2.80	2.49
Mexico	17.69	11.79	8.78	7.04	5.83	5.03	4.42
Middle East	27.58	18.54	13.79	11.17	9.27	7.85	6.89
South America	18.87	12.58	9.35	7.55	6.29	5.39	4.67
Southeast Asia	10.11	6.74	5.05	4.00	3.37	2.84	2.42
Taiwan	43.40	28.93	21.84	17.47	14.47	12.28	10.65

Individual Products Analysis

For individual analysis, we focused on three products: cheese, whey, and NFDM, because they are the most promoted commodities of all U.S. dairy products, and they comprise the largest proportion of the total dairy export value during the period of study. We examined how effective the promotion expenditures for these three products have been during the past decade using econometric methods. Here, the export quantities were measured on a product basis (in tons). In the analysis, we excluded the EU, because most expenditures to the EU were used to support administrative activities rather than to promote a specific product.

I. Cheese

Similar to the aggregate estimation, we started the estimation from fixed effects and random effects regressions. The random effects model was rejected because it had an over-identifying problem over time according to the Sargan-Hansen statistic. Secondly, we tested the

original fixed effects model using four criteria: heteroskedasticity, autocorrelation, cross sectional correlation, and multi-collinearity. The regression was free from multi-collinearity problem because VIF was 1.79; whereas, the modified Wald test, the Wooldridge test for autocorrelation, and the Pasaran CD test proved the existence of another disturbance. Thus, we further employed the PCSE technique. Thirdly, we analyzed if there was an endogeneity problem in this demand model which results from simultaneous causality bias. And, we also utilized the exchange rate, GDP per capita, and the price of U.S. competitors as instrumental variables. The Hausman test indicated the necessity of including IV in the regression. Overall, we adopted the estimators from PCSE with IV regression. (Table 13)

Table 13: Estimation Results for Cheese, Whey and NFDM Import Demand

	PCSE IV	Fixed Cluster	Fixed effect Robust
VARIABLES	Ln(cheese)	Ln(whey)	Ln(NFDM)
Ln(GDPpp)	0.456***	1.536***	1.900**
	(0.134)	(0.400)	(0.817)
Ln(RER)	0.0102	2.062	1.387
	(0.0611)	(1.117)	(1.262)
Ln(Price $_{us}$)	-0.586*	-0.840**	-0.719
	(0.350)	(0.273)	(0.516)
Ln(Price $_{non}$)	0.665**	0.472	1.142
	(0.294)	(0.355)	(0.907)
Ln(Expenditure$_c$)	0.186***	0.0272	0.285**
	(0.0609)	(0.117)	(0.0979)
Constant	2.614	2.760	-3.802
	(1.827)	(5.572)	(11.39)
Observations	101	101	83
R-squared	0.837	0.585	0.285
Number of id	9	9	9

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The coefficients for all determinants are consistent with our expectation. The elasticity of cheese expenditure is 0.186, less elastic than the aggregate model, which means that if we increased the cheese expenditures by 1%, we would expect the total cheese export demand to increase by 0.186 %. The price elasticities for both U.S. dairy exports and the competitors were less than 1, far lower than the price elasticities from the aggregate model, which indicates that importers are not sensitive to the prices of U.S. cheese.

Based on the econometrics results, we simulated the demand for cheese over the most recent six-year period from 2006 to 2011 for each market following the similar steps in the aggregate analysis. We found that during the period, export promotion had simulated total cheese exports by 0.16 million tons, or an average of 26,000 tons per year. The U.S. cheese exports would have been about 42% lower than they actually were without the promotion. The average BCRs ranged from 14.35 ($\varepsilon = 2$) to 3.93 ($\varepsilon = 8$), and the marginal BCRs ranged from 4.43 ($\varepsilon = 2$) to 1.24 ($\varepsilon = 8$). These results suggest that the market development programs had a positive impact on increasing the export of cheese, and that more investment for promoting cheese is acceptable. However, the average BCRs and marginal BCRs for cheese are lower than those of the aggregate model, which implies the investment in cheese might not be as profitable as it would be for other products.

Table 14: Cheese: Annual Average Benefit Cost Ratio for U.S. Dairy Market Development Program 1999-2011

	Own-price elasticity of Export Supply						
	2	3	4	5	6	7	8
Change in producer price ($1000/ton.)	0.87	0.61	0.46	0.38	0.32	0.27	0.24
Change in producer surplus (million $)	33.14	23.00	17.61	14.26	11.98	10.33	9.08
Change in promotion cost (million $)	2.31	2.31	2.31	2.31	2.31	2.31	2.31
Benefit-cost Ratio	14.35	9.96	7.62	6.17	5.19	4.47	3.93

Table 15: Cheese: Marginal Benefit Cost Ratio Due to Market Development Program 1999-2011

	Own-price elasticity of Export Supply						
	2	3	4	5	6	7	8
Change in producer price ($/ton.)	21.47	14.30	10.72	8.57	7.14	6.12	5.36
Change in producer surplus (million $)	1.06	0.71	0.53	0.42	0.35	0.30	0.30
Change in promotion cost (million $)	0.24	0.24	0.24	0.24	0.24	0.24	0.24
Benefit-cost Ratio	4.43	2.95	2.21	1.77	1.47	1.26	1.24

II. Whey

Table 13 also lists the estimation results for whey. We used the typical analytical process that we had applied to the aggregate and cheese export demand model. Through a series of diagnoses, we rejected the random effects, because we needed to control regional factors that might affect the demand for whey exportation over time. In addition, we also doubted the consistency of the fixed effects regression, because there were heteroskedasticity and first order autocorrelation disturbances in this model. Hence, we included the cluster option in the fixed effects model. In addition, the model is free from endogeneity problem because the Hausman test and the Durbin-Wu Hausman test were not significant in differentiating the original model and the model including an instrument variable. In sum, we tended to trust the estimation from fixed effects with cluster option. The coefficients for all variables are consistent with the original expectations, among which GDP per capita and the price of U.S. whey were shown to be significant. The elasticity for GDP per capita is greater than 1, which indicates that the U.S. whey is a luxury commodity among importers. However, the promotion expenditure for whey is not significant in the regression.

III. NFDM

Similarly, the effectiveness of the expenditures spent on milk powder promotion was tested through econometric methods. We began by generating a fixed effects regression and a random effects regression; the coefficient for product promotion was significant in both models. But the Hausman test rejected the random effects model, because of the over-identifying issue. Then, we tested the fixed effects model with a series of post-estimation tests, and the model was found to be heteroskedastic. So, we added the robust option in the fixed effects model to eliminate the inefficiency problem. According to the econometric results, the elasticity of NFDM expenditure was 0.285, which means a 1% increase in NFDM promotion would result in an increase of 0.285% in the quantity of NFDM export. . The elasticity of GDP per capita was greater than 1, which means the NFDM was probably considered a high value product among foreign importers.

A simulation analysis and a benefit-cost analysis was also included for NFDM. During the period, the promotion for NFDM increased the total NFDM export by 1.01 million tons, or an average of about 0.17 million tons per year. In the other words, the U.S. NFDM exports would have been 57% lower if there had been no such promotion activities. The average BCRs range from 220.97 for the most inelastic supply response ($\varepsilon = 2$) to 62.90 for the most elastic supply assumption ($\varepsilon = 8$) (Table 16). At the mid-point elasticity, the average BCR is 98.08, which implies that, on average, the benefits generated by market development expenditures on NFDM is about 100 times greater than the program expenditure. This is significantly higher than the results in the aggregate model, which means, on average, the NFDM generated more social welfare than other dairy products per dollar spent. In addition, the marginal BCRs ranged from 85.29 ($\varepsilon = 2$) to 21.23 ($\varepsilon = 8$) (Table 17). Because the marginal BCRs were greater than 1.0,

and higher than that in the aggregate model for every elasticity assumption we have considered, it would be more profitable for the industry and the government to spend more on NFDM.

Table 16: NFDM: Annual Average Benefit Cost Ratio for U.S. Dairy Market Development Program 1999-2011

	Own-price elasticity of Export Supply						
	2	3	4	5	6	7	8
Change in producer price (1000$/ton.)	0.77	0.54	0.42	0.35	0.29	0.25	0.22
Change in producer surplus (million $)	112.69	79.54	60.69	50.02	42.15	36.46	32.08
Change in promotion cost (million $)	0.51	0.51	0.51	0.51	0.51	0.51	0.51
Benefit-cost Ratio	220.97	155.96	119.00	98.08	82.65	71.49	62.90

Table 17: NFDM: Marginal Benefit Cost Ratio Due to Market Development Program 1999-2011

	Own-price elasticity of Export Supply						
	2	3	4	5	6	7	8
Change in producer price ($/ton.)	30.32	20.17	15.11	12.08	10.06	8.61	7.54
Change in producer surplus (million $)	6.49	4.32	3.23	2.59	2.15	1.85	1.61
Change in promotion cost (million $)	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Benefit-cost Ratio	85.39	56.80	42.55	34.02	28.34	24.29	21.23

CONCLUSION AND DISCUSSION

The main conclusion from this analysis is that market development programs have enhanced foreign demand for U.S. dairy products over the years, and they have generated an impressive positive return to producers for each dollar spent on promotion. Through the econometric analysis, the export promotion elasticity was computed to be 0.298 in the export demand equation and 0.03 in the Armington model, which means that a 1% increase in export program expenditures would result in a 0.298 % increase in total dairy export and a 0.03 % increase in market share in the selected foreign markets. The long-run promotion elasticity for market share was 0.51. The promotion was also significant for the export demand in both cheese and NFDM models, but not for the whey model.

Based on the simulation analysis, U.S. export promotion has stimulated the quantity of dairy exports by an average of 475 million pounds (or 59%) per year. Over the period of study, the average BCRs ranged from 10.06 for the most elastic assumption to 35.15 for the most inelastic one. The relative high average BCRs estimated for dairy export promotion indicated that this has been quite profitable for the U.S. dairy industry. The marginal BCRs were calculated to be between 5.36 and 21.51 per additional promotion dollar. Consequently, these results suggest that the U.S. dairy should have increased the level of promotion expenditures over this period. For individual commodities, the average BCRs and marginal BCRs for cheese were lower than that in the aggregate model, while for the NFDM, both average and marginal BCRs were significantly higher. Therefore, we recommend that the industry should invest more for the promotion of NFDM exports.

There are still several limitations of this study. First, we did not consider the change in consumer surplus under the inducement of non-price promotion activities. An increase in export

demand will transfer some proportion of dairy product from the domestic market to the international market in the short run, which results in a higher price in the domestic market (Kinnucan and Cai, 2010). This resulting increase in domestic prices would harm domestic consumers, and this has been ignored in this study. In addition, the paper did not discuss the economic shocks, like financial crisis, food safety scandal in China, and the influence of bovine somatotropin (bST), which might influence dairy exports. However, because we only have 12 observations for each market, the analysis for each might be insufficient. Moreover, the instrument variable is statistically reliable in the regression, but it still needs to be proven with further research.

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